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Effect of Different Essential Oils Against the Biology of Aphid (*Aphis craccivora* Koch) in Green Gram (*Vigna radiata* L.)

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ABSTRACT: An experiment was carried out to determine the effect of neem oil, mint oil, garlic oil, ginger oil, eucalyptus oil and clove oil on the biology of *Aphis craccivora* Koch in green gram during 2023-23 in the Department of Entomology, Biswanath College of Agriculture. Treatment with essential oils reduced the total development period of *A. craccivora* compared to the control group, with neem and mint oils resulting in the shortest development periods. The nymphal duration was significantly shorter in the treatment groups, with clove oil exhibiting the shortest first nymphal duration. Neem, mint, and garlic oils also contributed to shorter nymphal periods. Additionally, reproductive performance was affected by the treatments, with mint oil resulting in the shortest reproductive period and neem oil leading to the lowest number of off spring produced by a single female. The total number of off spring was significantly lower in the treatment groups, with the control group having the highest number.

Keywords: *Aphis craccivora*, treatment, essential oil, nymphal, reproductive.

INTRODUCTION

Aphis craccivora Koch (Homoptera: Aphididae) is a destructive pest of almost all cultivated crops (Blackman and Eastop 2017). Nymphs and adult of *A. craccivora* insects pose a threat to bean crops, affecting them from the early vegetative stage to the fruiting stage. Their presence can result in significant yield losses, reaching up to 100% in various legume species (Attia *et al*., 1986). It was found to infest fifty host plants from nineteen distinct plant families (Mehrparvar *et al*., 2012). *A. craccivora* can affect various parts of plants, including flowers and pods (Berberet *et al*., 2009). The extensive and uncontrolled application of synthetic chemical pesticides to combat this pest has led to ecological disturbances, in addition to their harmful impacts on various organisms, including humans. Consequently, there is an immediate requirement for the creation of environmentally sustainable techniques and materials (Rajappan *et al*., 2000). In recent years, essential oils derived from plants and their primary components, particularly monoterpenoids, have gained significant interest as potential tools for pest management due to their recognized insecticidal, repellent, and/or antifeedant qualities (Amos *et al*., 1974). Natural plant products, notably essential oils (EOs), offer several benefits as they are environmentally friendly, easily accessible, confirmed to be safe for mammals, and capable of targeting specific pests without leading to resistance issues, thanks to their intricate chemical makeup (Devrnja *et al*., 2022). Essential oils from plants are typically extracted through steam distillation of various plant parts, like leaves or flowers. The resulting oil is an intricate blend of volatile organic compounds (VOCs), which are secondary metabolites, particularly terpenoids, synthesized by plants in response to various stressors, including pest infestations (Picazo-Aragonés *et al*., 2020).

MATERIAL AND METHODS

Development of *A. craccivora* population on green gram crop: For the development of the aphid population, the green gram crop (var. IPM2-3) was grown in two plots, measuring 10 sqm (2.0 × 5.0 m) each. A gap of 1m was obtained between the two plots. The crop was raised following the recommended package of practices but without any insecticidal treatment, so that the population of the pest could build up freely. Observations were taken daily to record the appearance of the pest. Accordingly, the aphid population was collected to carry out the experiments in the laboratory. The experiment was laid out in complete randomized design (CRD) with three replications. Each replication consisted of seven treatments.

Preparation of oil solution. All essential oils were collected from the local market. Emulsifier tween 20 (0.02%) was used as a surfactant as the oil does not readily mix with water. Then distilled water was added to get different concentrations such as 1, 3 and 5 per cent. All solutions were stirred well so that oil and water could mix thoroughly. All essential oils were applied at three different concentrations *viz.*, 1%, 3% and 5%.

Biology of test insect. The healthy leaves of the green gram crop were collected from the experimental plot for the investigation of bio-assay against the tested insect, *A. craccivora*. The collected leaves were washed thoroughly with tap water and dried under laboratory conditions. The washed and dried leaves were examined under a binocular microscope and the presence of any living micro-organisms was removed from the surface of the leaves. After visual confirmation, leaves were cut into dishes (2.5 cm dia. each) and these discs were treated with already prepared different oil solutions at 1, 3 and 5 per cent concentrations. The treated disc was kept upside down on a wet filter paper (110 mm) and placed in a petri dish (9 cm dia.). A water-soaked cotton swab was also kept in each petri dish in order to maintain the hydrated conditions. In this way, a total of 21 numbers of petri dishes were ready for investigation. These were arranged in three replications along with seven treatments. Such type of arrangements were set up in three different batches for testing the efficacy of essential oils at 1, 3 and 5 per cent concentrations. Petridishes containing aphids (both nymph and adults) were case fully closed and kept at 25±1°C to count dead individuals and recorded the mortality percentage after 4, 12, 24, 48 and 72 hours of application. Mortality was confined by touching the tested individuals with a fine brush. Aphids that did not show the realistic movement were considered dead. The newly born first instar nymph and the individual alive during the bioassay study period were collected and transferred to the new petri dishes with available food material to study the biology of aphids.

RESULTS AND DISCUSSION

Total development period: The data in Table 1 showed that the toral development period of *A. craccivora* was affected by the application of essential oils. The total development period was reduced compared to the control when *A. craccivora* was treated with essential oils. The shortest development period was recorded in neem oil (15.66 days) and mint oil (16.00 days) followed by garlic (17.00 days), clove (17.33 days), eucalyptus (19.00 days) and ginger oil (19.33 days), respectively. The longest development period was recorded for control (23.33 days).

Duration of nymphal instars:

First instar: The data in Table 2 revealed that the shortest nymph duration was recorded in clove oil (1.16 days) followed by mint (1.33 days) which is statistically at par with garlic oil (1.33 days), ginger (1.50 days) and eucalyptus oil (1.50 days). The first instar duration was recorded in control (1.66 days).

Second instar: The data in Table 2 showed that the shortest nymph duration was recorded in neem, mint and garlic (1.16 days) followed by eucalyptus (1.33 days) and clove oil (1.50 days) respectively. The longest duration was recorded in the control (1.83 days).

Third instar: The data in Table 2 showed that the 3rd instar duration of *A. craccivora*. The shortest nymph duration was recorded in neem oil (1.33 days) and mint oil (1.50 days). The longest duration was recorded in eucalyptus oil (2.00 days).

Fourth instar: The data in Table 2 indicated that the shortest nymph duration was recorded in neem (1.50 days) which is statistically at par with clove (1.50 days). The longest duration was recorded in control (2.33 days) followed by garlic oil (2.16 days).

Table 1: Effect essential oils on the total development period of *A. craccivora.*

Oils	Duration in day(s) [Mean±S.Em.]
Neem oil	15.66±1.15
Mint oil	16.00±2.00
Garlic oil	17.00±1.00
Ginger oil	19.33±1.55
Eucalyptus oil	19.00±1.00
Clove oil	17.33±1.55
Control	23.33±4.50
S.Ed(±)	1.75
C.D (P=0.05)	3.76

Data represented are the mean of three replications with 10 insects each; Significant at P=0.05, NS-Non-significant

Table 2: Effect of essential oil on the duration of nymphal instars of *A. craccivora.*

Oils	Instar duration(days) [Mean±S.Em.]				Nymphal period (days) [Mean±S.Em.]
	1st	2nd	3rd	4th	
Neem oil	1.66±0.28	1.16±0.28	1.33±0.57	1.50±0.50	5.16±1.04
Mint oil	1.33±0.57	1.16±0.28	1.50±0.00	1.66±0.28	5.83±0.28
Garlic oil	1.33±0.57	1.16±0.28	1.50±0.00	2.16±0.76	6.60±1.15
Ginger oil	1.50±0.50	1.50±0.50	1.66±0.28	1.83±0.57	6.50±0.50
Eucalyptus oil	1.50±0.50	1.33±0.28	2.00±0.86	2.00±0.86	6.33±1.89
Clove oil	1.16±0.28	1.50±0.50	1.66±0.28	1.50±0.50	5.83±1.04
Control	1.66±0.28	1.83±0.76	1.5±0.76	2.33±1.15	7.83±1.60
S.E.d(±)	0.39	0.39	0.40	0.58	0.97
C.D (P=0.05)	NS	NS	NS	NS	NS

Data represented are the mean of three replications with 10 insects each; Significant at P=0.05, NS-Non-significant

Nymphal period: The data in Table 2 revealed that the shortest nymphal period was recorded in neem oil (5.16 days) followed by mint (5.83 days) and clove oil (5.83 days). The longest nymphal period was recorded in control (7.83 days).

Fecundity of *A. craccivora*: The data in Table 3 revealed that the shortest reproductive period was recorded in mint oil (1.50 days) followed by neem oil (3.40 days). The longest reproductive period was recorded in control (13.33 days) followed by eucalyptus (7.33 days), garlic (6.50 days) and ginger oil (5.83 days). The lowest number of offspring produced by a single female was recorded in neem and clove oil (3.00 nos/day). The lowest total no of offspring was recorded in mint (12.66 nos.) and neem oil (18.66 nos.). The total no of offspring produced by a single female was recorded highest in control (34.66 nos.) followed by garlic (27.66 nos.), ginger (25.66 nos.), eucalyptus (23.66 nos.) and clove oil (20.00 nos.).

Adult longevity: The data in Table 4 indicated that the shortest adult longevity was recorded in mint oil (10.16 days) followed by neem oil (12.16 days). The longest adult longevity was recorded in control (15.50 days) followed by ginger oil (12.83 days), eucalyptus oil (12.66 days) and clove oil (11.50 days).

The data in Table 1 showed that the total development period of *A. craccivora* was affected by the application of essential oils. The data revealed that the shortest development period was recorded in neem oil (15.66 days) followed by mint oil (16.00 days), garlic (17.00 days), clove (17.33 days), eucalyptus (19.00 days) and ginger oil (19.33 days) respectively**.** In contrast, the development period was comparatively prolonged in control (23.33 days). According to Vimala *et al.* (2010) the inhibition of neurosecretory cells caused by the active component, azadirachtin in neem-based pesticides interferes with adult development and egg formation, which affects aphid reproductive capability.

Table 3: Effect of essential oils on fecundity of *A. craccivora.*

Oils	Reproductive period(days) [Mean±S.Em.]	No of offspring (day/female) [Mean±S.E.m.]	Total no of offspring [Mean±S.E.m.]
Neem oil	3.40±0.50	3.00±1.0018	18.66±4.160
Mint oil	1.50±0.50	3.33±1.00	12.66±2.08
Garlic oil	6.50±1.32	4.00±1.00	27.66±1.52
Ginger oil	5.83±0.76	3.60±1.15	25.66±7.023
Eucalyptus oil	7.33±2.51	3.66±0.00	23.66±5.68
Clove oil	4.50±0.50	3.00±0.00	20.00±4.35
Control	13.33±3.05	3.66±1.15	34.66±6.11
S.E.d(±)	1.33	0.94	3.92
C.D (P=0.05)	2.86	NS	8.42

Data represented are the mean of three replications with 10 insects each; Significant at P=0.05, NS-Non-significant

Table 4: Effect of essential oils on adult longevity of *A. craccivora.*

Oils	Duration in day(s) [Mean±S.Em.]
Neem oil	12.16±3.88
Mint oil	10.16±1.75
Garlic oil	10.33±0.57
Ginger oil	12.83±1.44
Eucalyptus oil	12.66±1.04
Clove oil	11.50±3.12
Control	15.50±3.16
S.E.d(±)	1.86
C.D (P=0.05)	NS

Data represented are the mean of three replications with 10 insects each; Significant at P=0.05, NS-Non-significant

The findings are in agreement with Santos *et al.* (2004) who reported that the mean biological cycle of *Aphis gossypii* Glover was 17.00 days. In the present investigation, it was found that the first, second, third and fourth instars lasted an average of 1.66, 1.16, 1.33 and 1.50 days respectively for neem oil which was the shortest duration as compared to the control (1.66, 1.83, 1.5, 2.33 days). These findings agreed with Xia *et al.* (2004) who reported that first, second, third and fourth instars continued an average of 1.4, 1.3, 1.3, and 1.3 days respectively. The shortest nymphal duration was recorded in neem oil with an average of 5.16 days. El-Hawary (2008) found that the nymphal duration of *A. craccivora* was 6.4 days. The lowest number of offspring produced by a single female was recorded in neem and clove oil (3.00 nos./day). These findings corroborate with Stark and Rangus (1994) who found that the fecundity of pea aphid, *Acyrthosiphon pisum* was 2.33 nos./day. The lowest total no of offspring was recorded in mint (12.66 nos.) and neem oil (18.66 nos.). The total no of offspring produced by a single female was recorded highest in control (34.66 nos.) followed by garlic (27.66 nos.), ginger (25.66 nos.), eucalyptus (23.66 nos.) and clove oil (20.00 nos.). These findings corroborate with *Saifi et al.* (2023) who reported that total no of offspring produced by a single female of *A. craccivora* was 12.36 nos. From the Table 3, it is evident that the shortest reproductive period was recorded in mint oil (1.50 days) followed by neem oil (3.40 days). These findings agreed with Saıfı *et al.* (2023) who reported that *A. craccivora* reproductive period was 1.8 days due to the presence of menthone and cineol which is the main active ingredient of mint oil. It was found that the shortest adult longevity was recorded in mint oil (10.16 days) which was followed by neem oil (12.16 days). The longest adult longevity was recorded in control (15.50 days) followed by ginger oil (12.83 days), eucalyptus oil (12.66 days) and clove oil (11.50 days). The recorded result found due to the presence of ketone monoterpenes which is the most common active ingredient of *Mentha* spp. (Sánchez Borzone *et al.*, 2016). These findings agreed with Saıfı *et al.* (2023) who reported that *A. craccivora* adult longevity was 10.33 days at 1µ/ml application *M. longifolia* oil.

CONCLUSIONS

The research findings presented in this study highlight the significant impact of essential oils on the developmental and reproductive parameters of *Aphis craccivora*. The results revealed that the application of various essential oils had distinct effects on the aphid's life cycle and reproductive capabilities, offering valuable insights for pest management strategies. Notably, neem oil emerged as the most effective essential oil, significantly reducing the development period of *A. craccivora* to just 15.66 days. Mint oil also exhibited a noteworthy influence, with a development period of 16.00 days and the shortest reproductive period of 1.50 days. The active ingredients in mint oil, menthone, and cineol, were identified as key contributors to this effect, as they are known to impact aphid reproductive capabilities. Additionally, the study revealed that neem and clove oils resulted in the lowest number of offspring produced by a single female, at 3.00 nos./day, indicating their potential as effective tools for suppressing aphid populations. Furthermore, no experiments have been conducted to evaluate the impacts of essential oils on the demographic parameters of aphidsona large scale. Few studies on the insecticidal activity of essential oil have been reported against aphids.

FUTURE SCOPE

These natural compounds proved to be potent alternatives for controlling aphid populations and can contribute to integrated pest management strategies in agricultural systems. Further research and development can lead to the formulation of effective and economically viable essential oil-based products that can benefit farmers while promoting sustainable agricultural practices. Future research can be done on the effect of essential oils on the morphology and physiological behaviour of aphids.

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Conflict of Interest. None.

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